THE LATTICE QCD ROLE IN DETERMINING THE NUCLEON MASS SPLITTING

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ABSTRACT

Among the applications and tests of the QCD theory is to determine the proton-neutron mass difference, which is one of the fundamental physics problems to understand why our universe is the way it is. Because of the $O(1)$ strong force coupling at low-energy-quark bound states as the nucleon, non-perturbative lattice QCD (LQCD) calculations are required to determine its value as perturbative calculations are no longer valid. Though the value of $m_p - m_n$ has been measured in very high accuracy from nucleon experiments, theoretical calculations quantitatively determine in separate the electromagnetic force and the up-down quark mass difference contributions. This presentation focuses on my work on the lattice QCD determination of the EM force contribution of the proton-neutron mass splitting, with a reference on other published LQCD results.

I am currently a postdoc researcher at Indiana University. Our research group is part of the MIMD Lattice Computation (MILC) Collaboration, working on LQCD subjects mainly using the staggered quarks on the lattice. Because of the 16-fold doubling problem with fermions on the 4-d lattice, solutions have to be applied before any lattice calculations being performed. The staggered quark is among several solutions to this problem. It’s main advantage is the remaining $U(1)_A$ chiral symmetry on the lattice. This work uses the Asqtad MILC ensembles for the gluon fields with dynamical quarks. Besides, sets of the non-local baryon operators that follow the discrete lattice group, the so-called GTS group for staggered quarks, were generated for improved data quality in baryon propagators.